A transmission comprising a displaceable shift fork and an actuator

The invention relates to a transmission comprising a displaceable shift member by means of which the transmission can be shifted, wherein the shift member is displaceable by means of a shift fork moved by an actuator and the actuator has a motor, a shaft, a gate and a spring accumulator and wherein a rotational movement of the shaft is translated into a displacement of the shift fork by means of the gate. The shift member can be a part of a shaped-matched clutch, in particular a clutch sleeve or a synchronization unit, or can be another moving transmission member, in particular a planetary gear.

Transmissions of this type are used inter alia in transfer cases of all-wheel drive motor vehicles to make available a road gear and an off-road gear.

A generic planetary gear is known from EP 659 605 B1.
The gate roller herein is driven by the shaft supporting it via a rotary spring. The latter serves as a force accumulator when the shape-matched clutch member does not immediately find the engaged position. This design is complex and makes it necessary to guide the shift fork on a rail in the displacement direction, which further enlarges the required construction space and results in a defective guiding. The angular position of the shift gate is never accurately determined; no abutment is present and the force with which the shift member is held engaged is not defined. The disconnection in the end position is also not reliable.

It is therefore the object of the invention to improve a transmission comprising an actuator such that it is simpler, more reliable and more accurate with a minimum installation space.

It should establish a reproducible association of the angular position of the gate and the position of the shift fork and only yield on the exceeding of a specific actuation force.

This is achieved in accordance with the invention in that the gate is formed on a sleeve rotationally fixedly connected to the shift fork, with the sleeve acting on the shift fork via the spring accumulator in the direction of the displacement, and in that the shaft passes through the sleeve and has a radially projecting finger which cooperates with the gate. In this connection, a gate is to be understood as a substantially helical groove with guide surfaces to both sides of the finger which thus establishes the association of the rotation and the displacement in both directions of movement. Since the sleeve does not rotate with the gate and the gate is inwardly open, the finger can engage into the gate from the inside. Since the spring accumulator of the gate is downstream in the force flow, the association between the angle of rotation of the shaft of the actuator and of the displacement position of the sleeve is fixed.
The spring accumulator then only acts between the sleeve and the shift fork.
The spring accumulator comes into effect when the two clutch parts are, for example "out of mesh". The gate can then be displaced up to and into its end position without taking along the shift fork. When the shift member can then move, that is when, for example, the teeth of the clutch are slightly displaced with respect to one another, they are brought into engagement by the energy stored in the spring. It is also achieved with this arrangement that the force acting back on the electric motor is limited when shifting takes place at low revs or when one of the clutch members to be connected undergoes an increase in revs.

In an advantageous and particularly space-saving embodiment, the shift fork forms a housing surrounding the sleeve and the spring accumulator and having support surfaces by means of which the shift fork is guided on the shaft in the direction of the displacement (claim 2). The housing protects the spring accumulator and simultaneously forms the guides on the rotating shaft which are relatively far away from one another. The fork shift is thereby accurately guided without an additional guide rail and the friction values are largely constant (no transition from static friction to sliding friction because the shaft is actually rotating).

In a further development of the invention, the sleeve is surrounded by a compression spring whose end windings cooperate with steps in the interior of the housing. (Claim 3). This is only possible since the finger cooperating with the gate on the sleeve engages into the gate from the inside. A single spring can thus act as a spring accumulator in both displacement directions.

In a preferred embodiment, the sleeve is fixedly connected in the direction of rotation and displacement with a holding yoke, said holding yoke consisting of a guide part and of one respective wing at both sides, with the guide part being guided on guide surfaces extending in the longitudinal direction on the housing of the fork shift and the two parallel wings being fixedly connected to the end regions of the sleeve and the compression spring being accommodated between them (claim 4). The holding yoke can be a simple sheet metal stamping. It establishes the rotationally fixed connection between the sleeve and the shift fork, thus hinders it rotation and holds the spring without fully surrounding it. The peripheral zones of the compression spring can thereby project beyond the wings in the radial direction, said peripheral zones cooperating with the steps in the housing. When the spring is furthermore pre-stressed

between the wings of the holding yoke (claim 5), the holding force is defined with which the shift member is held in engagement.

An advantageous detail consists of the fact that the fixed connection between the sleeve and the holding yoke is established in the peripheral direction by a nose engaging into a longitudinal groove and in the displacement direction by a collar and a spring ring (claim 6). The whole unit of actuator/shift fork/spring accumulator can thus be installed and deinstalled simply without any special devices. A further detail improvement consists of the fact that the finger projecting radially from the shaft has a rotatably journaled roller at its end cooperating with the gate (claim 7); the friction is thereby reduced, which permits an accurate and wear-free shifting.

The invention will be described and explained in the following with reference to Figures. There are shown:

Fig. 1 : a partial longitudinal section through a transmission comprising the actuator in accordance with the invention;

Fig. 2 : a longitudinal section according to BB, in Fig. 1;

Fig. 3 : a cross-section according to AA, in Fig. 1;

Fig. 4 : the actuator in accordance with the invention in axonometric projection and exploded;

Fig. 5 : a detail from Fig. 4 in another direction of view.

In **Fig. 1**, the transmission housing is indicated by two wall parts 1 in which a shaft 2 is rotatably supported which is set into rotation by a geared motor. A shift fork unit 4 consisting of the actual shift fork 7 and a housing 8 is seated on the shaft 2. The shift fork unit 4 furthermore has reinforcement ribs 9 and is made integrally as a cast part or as an injection molded part. The shift fork 7 engages in a known manner around

a shift member 5 which in turn rotates around an axis of rotation 6. This is also the axis of rotation of a transmission part (not shown) which cooperates with the shift member. The shift member can be a part of a shape-matched clutch, of a synchronization clutch or can itself be a toothed transmission member.

The housing 8 of the shift fork can be seen in section in **Figs. 2 and 3**. The shaft 2 is here a hollow shaft, for weight reduction, through which a finger or mandrel 11 passes which bears a roller 12 at its end projecting out of the shaft 2. The roller 12 engages into a gate 14 (see also Figs. 5 and 6) which is substantially a helical groove in a sleeve 13. The sleeve 13 is not rotatable with respect to the housing 8, but the rotatable shaft 2 passes through it. The sleeve 13 is thus displaced in the longitudinal direction on rotation of the shaft 2.

The sleeve is fastened in a holding yoke 16 for security against rotation. The latter is a stamped part of sheet metal bent into a U shape. It consists of a central guide part 17 and parallel wings 18, 18' projecting at both sides at a right angle. They have circular holes 19 which accept the sleeve 13. An inwardly projecting nose 20, which engages into a groove 23 of the sleeve 13 (see Fig. 5), is in at least one hole 18 for the rotationally fixed connection. The sleeve 13 has a collar 21 in one end region and a spring ring 22 in another end region for the connection fixed against displacement. The guide part 17 of the holding yoke 16 is guided in a manner described further below at the housing 8 of the shift fork unit 4.

A compression spring 24 is clamped as a spring accumulator enveloping the sleeve 13 between the wings 18, 18'. It acts as a single spring thanks to its particular attachment in both directions and is pres-stressed, so that the holding force of the actuators on the shift member is determined.

The winding diameter of the spring 24 is so large that its windings project beyond the wings 18, 18' of the holding yoke 16 in two peripheral zones 25 disposed opposite one another. The end windings 26 of the spring 24 can thus contact shoulders 30 unimpeded by the wings 18, 18' (see Fig. 3). A yielding displacement connection is thus established between the sleeve 13 and the shift fork unit 4. On engagement, for example, of a shape-matched clutch part, the spring 24 thus yields until the clutch parts have found one another.

The housing 8 of the shift fork unit 4 consists of an approximately cylindrical jacket surrounding only a part of the periphery and of two side walls 33 as base surfaces. The jacket leaves an opening 32 free at whose longitudinal rims guide surfaces 37 (see Fig. 3) are formed for the guide part 17 of the holding yoke 16. They form the displaceable security against rotation of the sleeve 13. An installation hole 35 is provided in the jacket 31 in the region disposed opposite to the opening 32. The side walls 33 for support surfaces which are supported on the shaft 1 and thus ensure a good guidance of the shift fork unit 4 on the shaft 2.

It can be recognized with reference to **Fig. 4** that the whole assembly can be installed easily. The spring 24 is first pre-stressed between the wings 18, 18' of the holding yoke and then the sleeve 13 is introduced into the holes 19 of the wings 18, 18' and fixed using the spring ring 22. This sub-assembly is then introduced through the opening 32 of the jacket 31 into the latter's interior.
In this process, the end windings 26 of the spring 24 contact the shoulders 30 in the housing. The shaft 2 can now be pushed through and the finger 11 can be inserted with the roller 12 through the installation opening 35 into the housing 8.

Fig. 5 finally shows the sleeve 13 and the holding yoke 16 and in particular the security against rotation by means of the nose 20 and the groove 23.